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COMPUTERIZED TRAINING SYSTEMS PROJECT ABACUS: FIFTH
YEAR STATUS REPORT(U) ARMY TRAINING SUPPORT CENTER FORT
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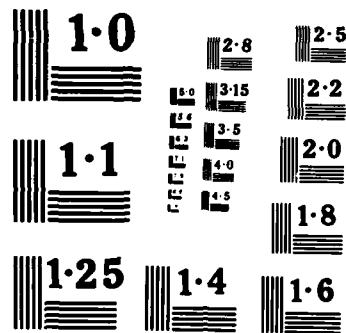UNCLASSIFIED CTD-TR-77-1

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PROJECT ABACUS

Report CTD – TR – 77 – 1

FIFTH YEAR STATUS REPORT
COMPUTERIZED TRAINING SYSTEMS PROJECT
PROJECT ABACUS

Donald A. Kimberlin

Test Branch
Communicative Technology Directorate
US Army Training Support Center
Fort Gordon, Georgia 30905

1 August 1977

DTIC

AUG 1

Prepared for:
US ARMY TRAINING AND DOCTRINE COMMAND
Fort Monroe, Virginia 23651

SOLDIER COMMUNICATORS
FORT GORDON
HOME OF THE SIGNAL CORPS
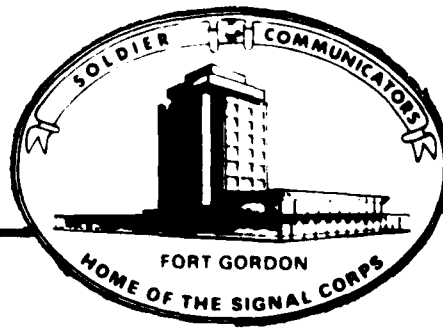
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This report has been reviewed and is approved.

Frank E Giunti

FRANK E. GIUNTI
Chief, Communicative
Technology Division
Training Developments Institute

Frank A. Hart

FRANKLIN A. HART
COL, IN
Director

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Fifth Year Status Report Computerized Training Systems Project Project ABACUS	Technical Report
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7. AUTHOR(s)	8. CONTRACT OR GRANT NUMBER(s)
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US Army Training Support Center Communicative Technology Directorate, Test Branch Fort Gordon, Georgia 30905	

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19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

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2. Instructional Models	7. Military Training
3. Training Technology	8. Computer Assisted Instruction
4. Educational Technology	9. Computer Managed Instruction
5. Curriculum Development	10. Self-Paced Training

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This report covers the actions which have transpired during the fifth year of Project ABACUS, the Army's program for the development of a Computerized Training System. It includes a narrative summary, key documents, and amplifying annexes. As a historical document, it will be utilized in preparation of the final project report. It is also meant to provide the current reader with an understanding of how the project has moved to its present position, and what actions are anticipated to be completed in the near future.

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FOREWORD

This report covers the actions that have transpired during the fifth year of Project ABACUS, the Army's program for the development of a prototype Computerized Training System. It includes a narrative summary, key documents, and amplifying annexes.

As a historical document, it will be utilized in preparation of the final project report. It is also meant to provide the current reader with an understanding of the progress to date of Project ABACUS, its present position, and what actions are anticipated to be completed in the near future.

ROBERT G. FOSTER
LTC, SigC
Program Director, Project ABACUS

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I.   INTRODUCTION

The mission of Project ABACUS is to design, develop, test and evaluate
a 128-terminal Computerized Training System (CTS), utilizing the multi-
minicomputer concept. At the conclusion of 5 years, the project is
in the test and evaluation phase.

II. BACKGROUND

The events leading to the implementation of the CTS project and the
progress through the first 4 years are documented in annual status
reports and are listed at Annex J. The Product Manager Charter and
DA Management Plan were reviewed as required on the project's anniver-
sary date, 1 August 1976. There were no changes made to either
document.

A new Memorandum of Understanding (MOU) between the Commander, US Army
Training Support Center (ATSC) and the Commandant, US Army Signal
School (USASIGS) was negotiated and signed by both parties on 17 May
1977 and 23 May 1977, respectively. A copy of the MOU is at Annex A.

III. PERSONNEL AND ORGANIZATION

There has been a reorganization of the Communicative Technology
Directorate (CTD), Ft Eustis, Virginia, into two divisions; the
Media Applications Division and the Systems Design Division. The Test
Branch is an element of the Systems Design Division. Mr. Donald
Kimberlin was transferred to the CTD as the Chief, Media Applications
Division effective June 1977. LTC Robert Foster remained as Program
Director, Project ABACUS and assumed the duties of Chief, Test Branch
on the transfer of Mr. Kimberlin. The present organizational relation-
ships are illustrated at Annex B.

The staffing of the Test Branch at Fort Gordon, Georgia consists of six
military and three civilians. One of the civilians will be transferred
to the Media Applications Division at Ft Eustis, Virginia in August
1977. During the past year, as vacancies occurred thru normal attrition,
the spaces in the Test Branch have been transferred to ATSC, Ft Eustis,
Virginia. This has been consistent with the decreasing workload as the
project nears completion. A roster of personnel is at Annex C. The
organizational relationship between USASIGS and Project ABACUS is at
Annex D.

IV. COMPUTER SYSTEM

A. Summary of Procurement. The following is a summary of the
major procurement actions that have been initiated or completed during
the fifth year of the project. A summary of major procurement actions
thru the first 4 years is at Annex E.

1. October 1976 - System passed the Phase III Acceptance
Test and was accepted by the Government.

2. May 1977 - Maintenance contracts were negotiated.

3. May 1977 - Modification to RSX-11 ordered to provide
real time operational capability.

B. Status.

1. The Human Resources Research Organization (HumRRO) was
placed under contract to conduct the acceptance testing of the system
for the Government. A three phase acceptance test was prepared for
the system and executed. Phase III was successfully run during the
period 19-30 July 1976 after two previous failures. The contractor,
GTE-Sylvania, resolved several shortcomings, problems, and discrepancies
to the satisfaction of the Contracting Officer's Technical Representative
(COTR), LTC Robert Foster. After the delivery and acceptance of the
final reports from GTE-Sylvania and HumRRO, the system was accepted
for the Government on 22 October 1976. These reports are listed at
Annex J.

2. The system maintenance contract with GTE-Sylvania was
scheduled to expire 31 December 1976. The delays in processing new
maintenance contracts resulted in extensions of the existing contract
until May 1977. New contracts were awarded effective 1 May 1977.
These contracts cover the period May 1977 to September 1979. The
Government has two 1 year renewal options beginning 1 October 1977.
Two companies were awarded the maintenance contracts. Engineering
Services Corporation, San Diego, California was awarded the contract
to maintain the central processors and peripheral equipment.
International Computer Equipment, Incorporated, Atlanta, Georgia won
the contract to maintain the terminals, terminal interface equipment,
and video transmission amplifiers.

V. COURSE DEVELOPMENT

A. Current Status. Course development has continued to progress
at an uneven pace. The courses were scheduled for implementation

relative to system acceptance (D-day).[1] The DD Form 250 accepting the system for the Government was signed by the Contracting Officer's Technical Representative on 22 October 1976. The implementation of the courses is as follows:

Course	Programmed Implementation*	Implementation**
31E20	D+90 (29 Jan 77)	10 Jan 77/5 Jul 77
35L20	D+150 (30 Mar 77)	11 Apr 77/1 Oct 77
31J20	D+180 (29 Apr 77)	11 Jul 77/1 Nov 77

* 1 November 1976 established as D-day

**Initial implementation/Full implementation

The reprogrammed implementation dates were established in reply to a message to Commandant, USASIGS from the Commander, ATSC. A copy of this correspondence is at Annex F.

B. Problems Encountered.

1. The significant factor affecting the progress of the 31E20 MOS course has been the re-allocation of personnel available for course development. The two instructional programmers provided to the USASIGS by the Test Branch, ATSC were transferred from ATSC. One instructional programmer was transferred by Department of the Army orders in December 1976 to duty as a drill sergeant, and the other, a civilian, accepted a position within USASIGS in April 1977. It was determined that the advanced state of courseware preparation made it impractical to requisition replacement personnel. Initially, USASIGS designated five individuals per MOS as instructional programmers for course development. During the period of this report, three instructional programmers were assigned, and on occasions as annexes were implemented and student load increased, only one remained full time in course development.

2. The 35L20 MOS course development effort has had only two instructional programmers assigned for the past year. For several months a Test Branch instructional programmer was shifted from the 31E20 course to augment the 35L20 development effort.

3. The 31J20 MOS course has essentially maintained a full complement of course development personnel, four, for the past year. The Test Branch, ATSC has kept the same personnel, one military and one civilian, assigned since late 1974. However, the civilian from the

[1]"Fourth Year Status Report, Computerized Training System, Project ABACUS," 1 Aug 76, p.4.

3

Test Branch is scheduled for transfer to ATSC, Fort Eustis, VA in August and will not be replaced. There have been a number of changes in the Program of Instruction (POI). An approved POI was finally implemented in July 1977. This instability has caused a significant amount of rewriting and reprogramming.

VI. SYSTEMS AND APPLICATIONS PROGRAMMING

Current Status. The systems and applications programming effort is completed with the exception of two programs. These are the question and test analysis runs. Just prior to completion of these two programs, a major file restructuring was required to accommodate the large amount of data being generated. These two programs are being entered into the system and are scheduled to be operational by the end of August 1977. The continuing programming effort for Project ABACUS will be to prepare final documentation and continue program maintenance. The USASIGS hired a civilian in June and assigned him to application programming for the CMS preparatory to the USASIGS takeover of the system after the evaluation.

VII. PROJECT EVALUATION

A. Final Evaluation Report. A contract to perform the final evaluation of the prototype CTS and to provide guidance to training directors on the subject of training, technical and cost effectiveness and associated benefits in support of self-paced training courses and management of instruction was awarded HumRRO, 27 July 1977. HumRRO will coordinate the evaluation with Test Branch personnel. The milestone chart is at Annex G. The final report is scheduled for delivery the end of May 1978.

B. The Computer Systems Support and Evaluation Agency conducted a hardware technical evaluation of the ABACUS system using system monitors. The report of this evaluation is at Annex H.

C. Course Implementation.

1. The Field Radio Repair Course, MOS 31E20, implemented the CTS in January 1977. Implementation began in the last training annex of the course and has progressed satisfactory toward the front end of the course. One shift operation of the entire course commenced in July 1977. Second shift operation is scheduled for August 1977. The course is operating in the Computer Managed Instructional (CMI) mode. This is a hard-skill course using the functional hands-on training concept; therefore, very little Computer Assisted Instruction (CAI) is used. However, there is extensive on-line testing.

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a. The current POI was implemented August 1976, using self-pacing as the method of instruction. In January 1977, the CTS was implemented, using the computer as a CMI tool. Less than 10% CAI is utilized in this course. In April 1977, a major change to the POI occurred when training on the AN/GRC-46 was implemented.

b. Data collection for comparative purposes is very difficult in this course due to its dynamic status.

2. The Teletypewriter Equipment Repair Course (MOS 31J20) implemented a new POI 8 August 1977 with seven students. POI time within the course was changed to accommodate additional equipment training. CTS is scheduled to be implemented in August 1977, with the entire course scheduled to be using CTS in November 1977.

3. The Avionics Communication Equipment Repair Course (MOS 35L20) implemented a new POI April 1977. This POI resulted in extensive changes to the internal makeup of the course, due to the addition and deletion of equipments. It is anticipated that by September 1977 approximately 50% of the course will be on-line with the entire course scheduled to be in operation by October 1977. Validation of CTS is progressing satisfactory, and a few students have completed the course using CTS in a CMI mode.

D. Data Collection Status.

1. The Field Radio Repair Course (MOS 31E20) POI implemented in August 1977 resulted in a number of changes between the old and new POI. This invalidates a significant amount of baseline data that could have been used for a comparative evaluation.

a. Data was collected during the period September 1976 thru December 1976 on the students undergoing self-paced training. A total of 59 samples were collected on Electronics (EL) and General Technical (GT) aptitutde scores and progression indices[2] of each task.

b. During the period January-March 1977, 85 samples were collected on CTS training. It must be emphasized that CTS was implemented in January, and this data could easily change as more instructors and course people become more effective in using the computer as a media. Tasks 1, 2, and 3 were still using self-pacing when this data was collected. A comparison of data collected September 1976-March 1977 (self-paced training) and data collected January-March 1977 (part self-paced and new CTS training) is at Annex I.

[2]Progression indices - A score of 1.00 indicates completion of that training in the allocated time. A score of .80 indicates completion in 80% of the allocated time.

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2. No task comparative data is available on the Teletypewriter Equipment Repair Course (MOS 31J20). Data collection, for comparative purposes, commenced with the implementation of the new POI, 8 August 1977.

3. Comparative data is incomplete on the Avionics Communication Equipment Repair Course (35L20).

E. Opinion Questionnaires.

1. The following opinion questionnaires have been administered:

a. Student attitude, self-paced instruction.

b. Instructor survey, self-paced instruction.

c. Staff and faculty survey, self-paced instruction.

d. Instructional programmer survey, CTS.

e. Course materials development survey, CTS.

2. Opinion questionnaires to be administered are as follows:

a. Student attitude questionnaire, CTS.

b. Instructor survey, CTS.

c. Staff and faculty survey, CTS.

d. Instructional materials survey, CTS.

e. Operational reports survey, CTS.

f. Resource allocation survey, CTS.

g. Instructional process survey, CTS.

h. Revised and alternate training materials survey, CTS.

i. Maintenance of student records survey, CTS.

j. Training management survey, CTS.

k. Task survey, CTS.

l. Administrative support survey, CTS.

Report on the Performance Measurement and Analysis

of the

Project ABACUS

Digital Equipment Corporation PDP 11/35

Computerized Training System

By The

U.S. Army Computer Systems Support and Evaluation Agency

Washington, DC 20310

GERALD B. DARGUSCH
GERALD B. DARGUSCH
Computer Specialist

15 April 1977

DEPARTMENT OF THE ARMY
U.S. ARMY COMPUTER SYSTEMS SUPPORT AND EVALUATION AGENCY
WASHINGTON, D.C. 20310

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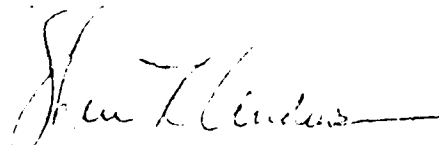
SUBJECT: Report on the Performance Measurement and Analysis of Project
          ABACUS

Commander
US Army Training Support Center
ATTN: ATTSC-CT
Ft. Eustis, VA 23604

1. Reference ltr, ATTNG-TA-TS, 12 Jan 77, subj: Performance Measurement
and Analysis for Project ABACUS Computer System.

2. Inclosed is the report on the Performance Measurement and Analysis of
Project ABACUS. USACSSEA is pleased to have provided assistance to the
US Army Training Support Center and will continue to be available for
assistance to your command. However, since this Agency's Performance
Measurement and Analysis resources are in short supply and in great demand,
it is requested that any future requirements for assistance be requested
four to six months in advance.

FOR THE COMMANDER:

1 Incl   WILLIAM R. ANDREWS
as   CPT, AGC
                                        Adjutant

CTS
FINAL REPORT MILESTONES

IN REPLY REFER TO

ATSN-DS-DS

8 JUL 1977

SUBJECT: Project ABACUS Evaluation

Director
USA Training Support Center
ATTN: ATTSC-CT
Fort Eustis, Virginia 23604

1. Reference message 012044Z Jun 77, Subject: Project ABACUS Evaluation, which requested information relative to evaluation of Project ABACUS.

2. Anticipated conversion dates are as follows:

a. Teletype Equipment Repair (31J) is scheduled to begin implementation with a new program of instruction on 11 July 1977 with total implementation by 1 November 1977.

b. Avionics Communication Equipment Repair Course (35L) began implementation in April 1977 with total implementation scheduled for 1 October 1977.

3. The approximate number of students that will complete the 31J and 35L Courses prior to 16 December 1977 are:

a. Teletype Repair (31J) - 117

b. Avionics Equipment Repair (35L) - 87

4. Recommend that Annexes E and K (94 hours) from the Teletype Repair Course and Annexes F and K (202 hours) from the Avionics Equipment Repair Course be considered for evaluation. These annexes represent lesson material which is closest to completion of student validation and will provide the most data for evaluation.

FOR THE COMMANDANT:

HEINZ W. LICHTENRAD
Captain, Infantry
Adjutant

02

b. Approximate number of students that will have completed each of the two courses, cited in 2a, by the termination date.

c. A recommendation as to which courses should be included in the final evaluation based on the number of students estimated to have completed the courses by the termination date.

3. POC is Mr Giunti, AUTOVON 927-5902/5339.

C

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NO   0120-4442 Jun 77

CDRUSATNGSPTCTR FT EUSTIS VA //ATTSC-CT//
CORDT USASIGSCH FT GORDON GA //ATSN-D/AC//

INFO: CDRUSATNGSPTCTR FT GORDON GA //ATTSC-CT-SDT//

UNCLAS

SUBJECT: Project ABACUS Evaluation

A. Visit 2-4 May 77 LTC Caravana, ATSC to USASIGS

1. During ref visit it was discussed that the final evaluation report
on Project ABACUS should be completed by April 1978. Indications are
that this is a realistic target date and planning continues to meet
that date. Accordingly it will be necessary to terminate data col-
lection from the three USASIGS courses now implemented on the Project
ABACUS computer system NLT 16 December 1977.

2. Using 16 December 1977 as the data collection termination date
it is requested that the following information be provided this
office NLT 5 July 1977 so as to facilitate planning:

     a. Anticipated conversion dates for the Avionics Communication
Equipment Repair Course, MOS 35L20 and the Teletype Equipment
Repair Course, MOS 31J20.

NIGHT L. CARAVANA, LTC, IN, D'r, CTD
          ..., 1 Jun 77   CONND: NO ...

/... ..., LTC, Commanding

                         UNCLASSIFIED

ANNEX E

LIST OF MAJOR
PROCUREMENTS

1. April 1973 - Request for a Proposal was issued to industry.

2. December 1973 - GTE-Sylvania, Inc., was awarded the contract.

3. April 1974 - Initial computer system was delivered to the Office of the Product Manager.

4. July 1974 - Initial 32-terminal display controller was delivered to the US Army Signal School (USASIGS).

5. May 1975 - Full, six processor multiminicomputer system was delivered and installed, including sixteen terminals. One hundred and twelve terminals were placed in local storage.

6. June 1975 - Communications study was completed.

7. July 1975 - Communication and cabling contract negotiations were conducted.

8. July 1975 - FY76 maintenance of CTS contract negotiations were conducted.

9. February 1976 - Alphanumeric system terminal was purchased.

10. February 1976 - Communications installation completed and full 128-terminal system installed.

11. February 1976 - Operating system RSX-11D, version 6B, was purchased.

12. June 1976 - FY7T and FY77 maintenance contract negotiations were conducted.

13. June 1976 - Maintenance spares for the Project ABACUS System were purchased.

STRUCTURE, TEST AND EVALUATION
ORGANIZATIONAL RELATIONSHIPS
Project ABACUS

Program Director
Project ABACUS

Evaluation

System Analysis
and
Programming

Instructional
Technology

Task Group Leader
USAIGS

MOS Courses

System
Operation
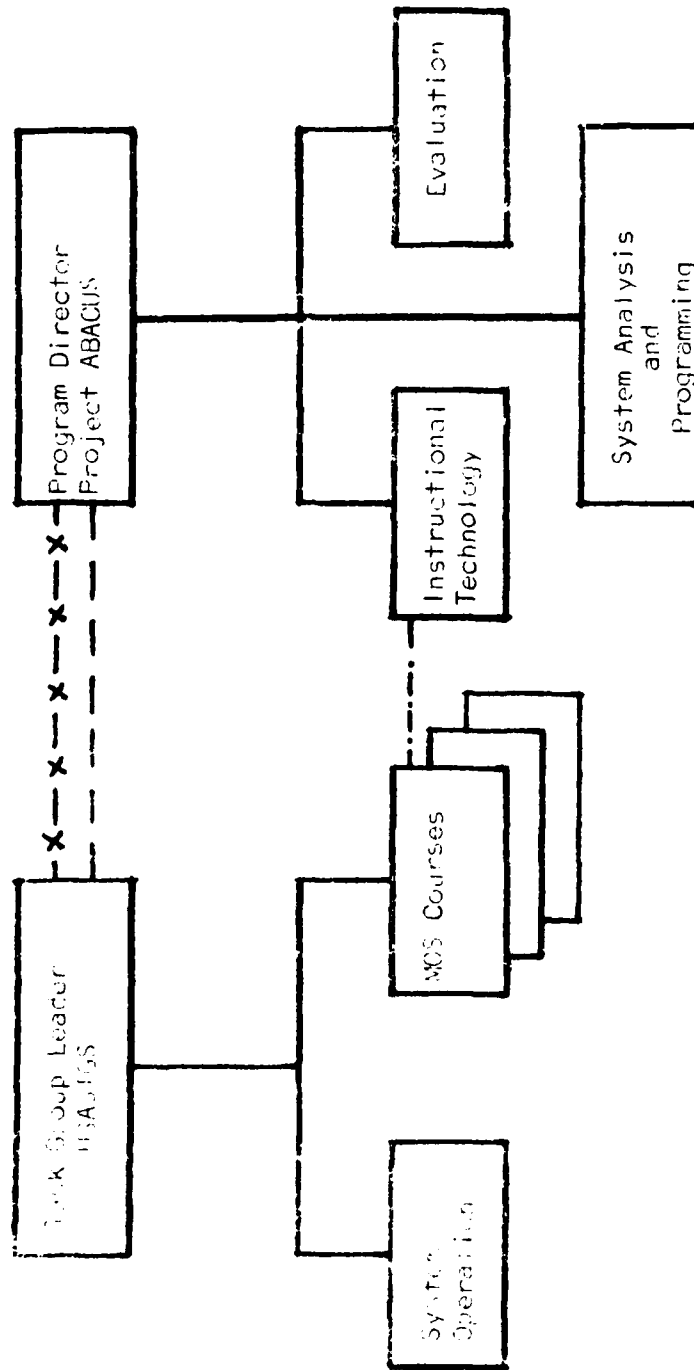
Command and Control

—X— Monitor and Coordinate

Technical Advice

Augment, Training & Support, but is under
team. This is under normal
operational control.

PERSONNEL ROSTER - PROJECT ABACUS

Name	Rank/Grade	Job Title	Duty Dates
			1 Aug 76 — 1 Jan 76 — 31 Jul 77
FOSTER, ROBERT G.	LTC	Prog Dir	
KIMBERLIN, DONALD A.	GS-13	Chief, Test Branch	
WICKERT, DAVID A.	2LT	ADP Off	
MUSSELWHITE, HARRY A.	GS-12	Ed Spec	
ALTMAN, BRYAN D.	GS-11	Ed Spec	
LAMB, JANET M.	GS-11	Ed Spec	
BROWN, DONALD L.	SFC	Instr Prog	
DIXON, JOHN W. JR.	SFC	Instr Prog	
HOOKER, BERNARD L.	SFC	Instr Prog	
STOTTS, JAMES D.	SSG	Admin NCO	
DUNCAN, WILLIAM L.	SP5	Programmer	
HUTSKO, GARRETT L.	SP5	Programmer	
MALCOLM, VARA G.	SP5	Programmer	
MASHEY, JOEL A.	SP4	Programmer	
ZARSKY, DAVID J.	SP4	Programmer	
JANTZEN, RATLI A.	GS-4	Clerk	
LANE, JUDY	GS-4	Clerk	

ATSC ORGANIZATIONAL CHART

```
                    +------------------+
                    |    Commander     |
                    | US Army Tng Spt Ctr |
                    +------------------+
                            |
                    +------------------+                        +------------------+
                    |     Director     |                        |      Chief       |
                    |   Communicative  |------------------------| Media Applications |
                    |    Technology    |                        +------------------+
                    |   Directorate    |
                    +------------------+
                        |        |
          +- - - - - - -+        |
          |                      |
  +------------------+   +------------------+
  | Product Manager  |   |      Chief       |
  |     ARTADS       |   | Systems Design Div |
  +------------------+   +------------------+
                                |
                        +------------------+
                        |      Chief       |
                        |   Test Branch   *|
                        +------------------+
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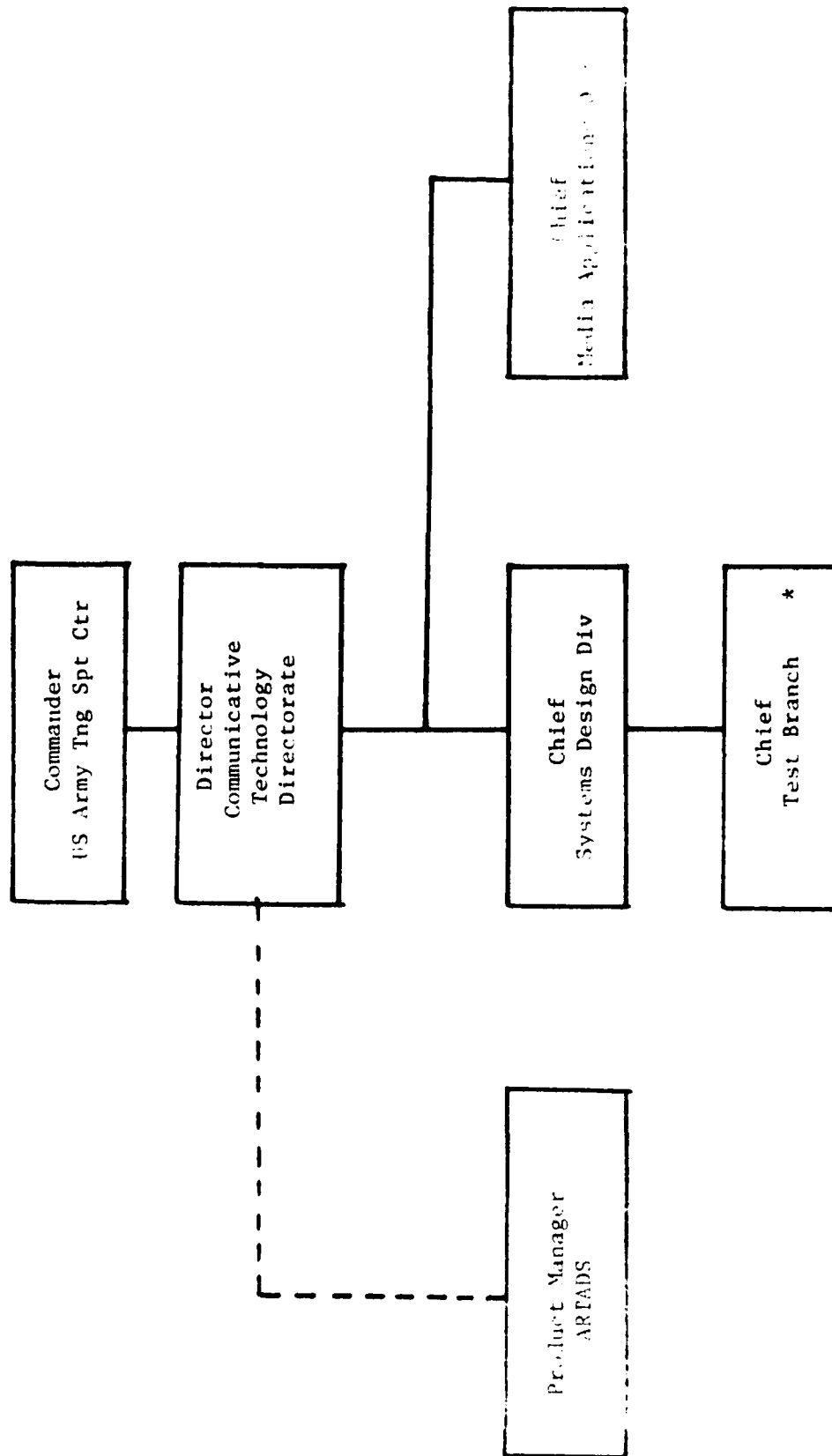
* IDA with Jury Project ABACUS, Fort Gordon, GA

(7) Accept full responsibility for the system established at Fort Gordon at the conclusion of the operational test and evaluation for use in accordance with TRADOC regulations in effect at that time.

(8) Provide for system maintenance beginning 1 Oct 77.

4. OTHER

a. Funding:

(1) Cdr, ATSC, is responsible for programming and funding FY77 as pertains to hardware/software acquisitions and associated contract change orders and system maintenance.
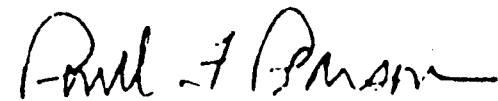
(2) The Commandant, USASIGS, will provide FY77 OMA funds for normal operating supplies, computer consumables, magnetic tapes, discs, and disc packs.

(3) The Commandant, USASIGS, will fund for maintenance of the system commencing 1 Oct 77 (FY78).

b. Responsibilities for items not specifically covered in this Memorandum of Understanding will be resolved by mutual coordination.

c. This Memorandum of Understanding is in effect until the conclusion of the operational test and evaluation, or when major program changes are made by higher headquarters.

d. This Memorandum of Understanding is effective on the date of signing by the Cdr, ATSC, and the Commandant, USASIGS.

PAUL F. PEARSON, BG
Commander, ATSC

CHARLES R. MYER, MG
Commandant, USASIGS

Date 17 May 1977

Date 23 May '77

A-3

the operational test and evaluation will be coordinated with the Commandant, USASIGS. The final document shall include Commandant, USASIGS, concurrence/comments.
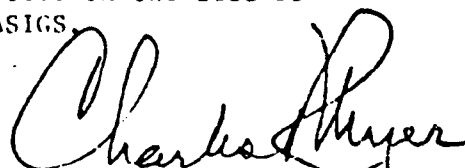
(2) Prepare appropriate program and planning documents as required by and for submission to higher headquarters.

(3) Collect data from the three courses participating in the operational test and evaluation of Project ABACUS.

(4) Advise the Commandant, USASIGS, of the progress and status of the operational test and evaluation, as required.

(5) Provide the computer systems engineer and software maintenance until the system is accepted by USASIGS.

(6) Provide system hardware maintenance through 30 Sep 77.

(7) Maintain a field office at the USASIGS, Fort Gordon, Georgia, until the operational test and evaluation of Project ABACUS is completed. This office is designated within the ATSC as the Test Branch, Systems Design Division, Communicative Technology Directorate (CTD), Fort Gordon, Georgia.

b. The Commandant, USASIGS, will

(1) Provide appropriate facilities for Project ABACUS in accordance with requirements established by the Cdr, ATSC.

(2) Operate the system hardware/software during the operational test and evaluation phase.

(3) Plan, program and budget additional system capacity not required by the operational test and evaluation. Any additional use of the system in this manner will be jointly concurred in.

(4) Provide the supervision and staff required to maintain the developed course material.

(5) Prepare, conduct and administer the Program of Instruction (POI) for the operational test and evaluation.

(6) Provide working space for personnel assigned to the Test Branch, ATSC, Fort Gordon, Georgia, and coordinate normal administrative support for personnel, to include records, finance and accounting, training and personnel actions.

ANNEX A

MEMORANDUM OF UNDERSTANDING

BETWEEN

Commander   Commandant
US Army Training Support Center   US Army Signal School
Fort Eustis, Virginia   Fort Gordon, Georgia

1. INTRODUCTION

    a. References:

    (1) USASIGS Reg 10-2, Organization, Mission and Functions, July 1973.

    (2) Prototype Computerized Training System Management Plan (as
revised 13 Nov 73).

    (3) Product Manager Charter, Prototype Computerized Training System
(as revised 5 Nov 73).

    (4) Letter, ATSN-CTS, USASCS, 29 Nov 73, Designation of Courses
for Prototype Computerized Training System (CTS), with 1st Ind, ATTS-ITP,
TRADOC, 11 Dec 73.

    b. In accordance with cited references, this Memorandum of Under-
standing (MOU) delineates responsibilities, command and control channels,
and procedures to be followed in the operational test and evaluation, to
include final report, of a Prototype Computerized Training System (Project
ABACUS) by the US Army Training Support Center (ATSC), Fort Eustis,
Virginia, and the US Army Signal School (USASIGS), Fort Gordon, Georgia.

2. GENERAL RESPONSIBILITIES

    a. The Commandant, USASIGS, reference 1a(1), is responsible for
preparing, conducting, administering, and maintaining the three courses,
reference 1a(4), during the operational test and evaluation phase of
Project ABACUS.

    b. Cdr, ATSC, is responsible for the design, hardware/software
development and maintenance, system control and data collection during
the operational test and evaluation phase of Project ABACUS.

3. DETAILED RESPONSIBILITIES

    a. The Cdr, ATSC, will

    (1) Conduct the operational test and evaluation of Project ABACUS
and prepare the required evaluation reports. Documents applicable to

A-1

3. Based on current implementation schedules and the established cutoff date (16 December 1977) for data collection, only the 31E20 course will be evaluated in its entirety. Selected annexes from the 31J20 and 35L20 will be evaluated.

VIII. RELATED PROJECTS

A. Computer Managed Instruction Project (CMI). A Concept Evaluation Program (CEP) study has been approved to evaluate the use of optical scanners as an input media to computers to manage the conduct of training for self-paced courses. The test proponent for this CEP is ATSC and USASIGS is the test organization.

B. Computer Application to Training and Simulation (COMTRAINS). A command study has been prepared to evaluate the Project ABACUS computer system. The objective of this study is to assess the hardware and software resources, the system configuration, and recommend an optimum use of the available resources for CMI applications in resident and nonresident training programs. The proposals by the respondents to a Request for Proposal (RFP) are being evaluated.

IX. CONCLUSION

This has been the year that saw the culmination of a 5 year effort to field a prototype computerized training system using the multi-minicomputer concept. The acceptance of the system for the Government put the project into its last phase, evaluation. As the USASIGS puts each course on the system, data is being collected and collated for the final report. The time lapse since the acceptance of the system and USASIGS implementation of the courses will permit the evaluation of the entire 31E20 course, but only selected annexes of the 31J20 and 35L20 courses. Regardless, there is a high degree of confidence that enough data will be available to make a valid evaluation of the computerized training system. The system evaluation by the CSSEA verified that there is ample capacity in the system for further training applications. This computer resource provides the USASIGS the opportunity not only to further automate training but to conduct projects to explore new training uses of the system and thereby become the Army's center of excellence for automated training systems.

Table of Contents

Management Summary

1. This report documents the Performance Measurement and Analysis (PMA) of the Project ABACUS Computerized Training System located at Ft. Gordon, Georgia.

2. The purpose of the PMA was to provide Project ABACUS personnel with information on system resource utilization.

3. The Project ABACUS Computerized Training System is comprised of six Digital Equipment Corporation PDP 11/35 minicomputers. The system is expected to support four hundred students.

4. The on-site measurement and analysis phase was performed 1-11 March 1977. The PMA revealed that:

   a. The high speed I/O channels have 94.42% unused capacity, and the low speed I/O channels have 80.12% unused capacity.

   b. The Data Base Controller CPU has approximately 90% unused capacity.

   c. The system, as designed and configured, is underutilized.

   d. Only one of the four DIVA disk drives on the Data Base Controller is required to hold all of the lesson material for three courses to be installed on the system.

   e. Transfer of three of the DIVA disk drives from the Data Base Controller to the System Controller would improve instructor programer productivity by an estimated 50% .

   f. The increased instructor programer productivity would be wasted unless additional courses are installed on the system or extensive revisions present course material are planned.

   g. The transfer of the three DIVA disk drives to the System Controller would require the purchase of a DIVA DC-234 disk controller.

   h. The purchase of a DIVA disk controller and transfer of the three disk drives to the Data Base Controller would result in a Digital Equipment Corporation (DEC) disk controller and 3 disk drives becoming surplus. If an Army installation required and could reutilize this equipment, then the total transaction would actually result in a saving to the Army of $18,600.

5. It is recommended that:

   a. The system, as designed and configured, should not be prolifer....

   b. The purchase of the DIVA disk controller be approved only if ...
is a demonstrated need and an Army installation guaranteed to reutili...
the surplused PEC equipment. Otherwise the three DIVA disk drives s....
be declared surplus.

H-5

I. Statement of the Problem. The US Army Training Support Center,
Ft. Eustis, Virginia, requested the Performance Analysis Branch of the
US Army Computer Systems Support and Evaluation Agency (USACSSEA) to under-
take a Performance Measurement and Analysis (PMA) of the Project ABACUS
(Army Based Automated Curriculim System) Computerized Training System (CTS)
located at Ft. Gordon, Georgia. The purpose of the PMA was to provide
Project ABACUS personnel with information on system resource utilization.

II. Facts Bearing on the Problem.

1. System description. The ABACUS CTS is made up of six Digital Equip-
ment Corporation (DEC) PDP 11/35 minicomputers and peripheral equipment
manufactured by DEC, Diva, Inc., and GTE-Sylvania. The six PDP 11/35 mini-
computers are used as follows: one as the System Controller, one as the
Data Base Controller, and four as Display Controllers. Each Display Controller
supports thirty-two display terminals. There are one hundred twenty-eight
display terminals on the system. The Data Base Controller is connected
to each Display Controller and to the System Controller using Direct Memory
Access (DMA) links. The value of the direct memory access link is that
data may be transmitted between main memories without interrupting the
CPU controlling the receiving main memory. The System Controller is con-
nected to each Display Controller via programed I/O links. The programed
I/O link is generally used when small volume data transfers are to be
made, because the CPU's controlling both the sending and receiving main
memories must execute instruction code to start and complete the data trans-
fer. A more detailed system configuration is provided in Appendix A of
this report.

2. Control software. The System Controller uses the DEC's RSX-11D
operating system. The Display Controllers and the Data Base Controller
do not use separate control software. Any functions normally handled by
control software are coded as part of the programs resident in the Display
Controllers and Data Base Controller.

3. Background.

a. The ABACUS computer system is a unique, one of a kind system.
It will not be proliferated in its present form; however, the knowledge
gained from the use of this system is expected to be useful in the develop-
ment of future systems.

b. The system was originally designed for Computer Aided Instruction
(CAI), which is somewhat similar in function to a programmed learning text.
The expected utilization of the system for CAI dictated a one second response
time at the display terminals.

c. The CTS is now used for Computer Managed Instruction (CMI), rather than Computer Aided Instruction. CMI does not require the short response times required by CAI and differs from Computer Assisted Instruction in that more supplemental material (e.g., printed manuals) is used by the student at the CMI terminal.

d. The system is capable of handling, on line, one hundred twenty students and eight instructors, concurrently.

4. Workload Description.

a. Courses to be supported. Three communications equipment repair coursesare to be installed on the CTS. They are Radio Repair (course 31E), Teletype Repair (course 31J), and Avionics Repair (course 35L). The Radio Repair course has been fully installed on the system; half of each of the other two courses has been installed on the system.

b. Present workload. Students began using the system in early January 1977, beginning a one year evaluation of the system. During the measurement phase of the PMA, approximately seventy-five students were using the system. Eventually, an expected average daily load of four hundred students will use the system for training. The rate of increase of student utilization of the CTS will depend on how quickly the instructor programmers are able to develop instructional material and compile it on the system. Because the actual workload placed on the system by the low number of students did not exercise the system sufficiently, a workload simulator was used to provide more system activity.

c. Simulated workload. The simulator used on the CTS was an actual lesson modified to replace the student with an automatic response based on a time limit determined from a random number. The simulator was run at two processing rates. The Slow Simulator response is timed to occur from twenty to forty-five seconds after the screen is displayed. The Fast Simulator response is timed to occur from ten to twenty seconds after the screen is displayed.

5. Time period of PMA. The PMA was conducted during the time period of 4 January through 25 March 1977. The time at the ABACUS site was divided into three phases:

a. First preliminary visit - 4 through 7 January 1977. Second preliminary visit - 25 through 27 January 1977.

b. The preliminary visits were used to determine problems to be addressed, or studies to be made during the Measurement Phase of the project.

c. Measurement Phase – 1 through 25 March 1977. The measurement of system performance and analysis of the data collected occurred during this phase of the project.

6. Resources supplied by USACSSEA.

a. COMTEN, Inc., D-8700 hardware monitor. This hardware monitor includes two types of data collection devices, described below, and stores the data collected on magnetic tape:

(1) The D-7916 hardware monitor which counts or times events using high speed electronic counters, the contents of which are written periodically to magnetic tape.

(2) The D-8048-II data controller which collects information into three sixteen-bit registers and stores this information in buffers, the contents of which are written periodically to magnetic tape.

b. COMTEN, Inc., DYNAPAR 6.3 data reduction software. This software formats the hardware monitor data stored on magnetic tape into printed reports for analysis.

7. Measurements to be performed. A copy of the Memorandum of Agreement between USACSSEA and the Training Support Center is in Appendix B. The planned measurements were:

a. General I/O activity for the system to include the following:

(1) All Direct Memory Access links, which connect the Data Base Controller to the System Controller and each Display Controller.

(2) All programmed I/O links, which connect each Display Controller to the System Controller.

(3) Data Base Controller disk activity, including seek in progress and unit busy time.

(4) System Controller disk activity, including seek in progress and unit busy time.

b. Main memory program (instruction address) mapping of the following:

(1) System Controller

(2) Data Base Controller

(3) Display Controller

c. Determination of CPU idle time on the following CPU's:

(1) System Controller

(2) Data Base Controller

(3) Display Controller

8. Scratch area contention measurement. This measurement involved counting the number of times the Display Controller software was unable to process display data because no scratch (work) area in memory was available for use.

III. Discussion.

1. Problems encountered.

a. Probe point development. The PMA team did not have satisfactory probe points for the project until 24 February 1977, because local site Customer Engineer personnel did not have the necessary expertise to provide the PMA team the probe points. This delayed the beginning of the measurement phase of the project until 1 March 1977; thus, the on-site measurement period was one week less than planned.

b. Data reduction support. Data reduction support was generously made available by the Savannah River Plant, Energy Research and Development Administration. However, the Savannah River Plant 1600 bpi tape drives could not read hardware monitor system's 1600 bpi magnetic tapes. This problem was resolved by copying the 1600 bpi tapes to 800 bpi at the Ft. Gordon Management Information Systems Office, before reducing them at the Savannah River Plant. The Savannah River Plant computer system had no trouble reading the copied 800 bpi tapes. However, the PMA team was not assured they could reduce their raw data until the third week of the on-site measurement, 16 March 1977.

c. Strobe for instruction address data. Attempts to synchronize a nine-bit signal pattern with the Unibus register, on the DEC PDP 11/35, containing an instruction address proved unsuccessful. However, useful instruction/data fetch address map data was collected using a simple single line strobe, beginning 22 March 1977.

2. Studies not completed.

a. No instruction address map of the Data Base Controller was made, due to a lack of available time.

b. It was intended to use the D-7720 Bit Comparator to directly measure idle time on the System Controller, and to collect idle loop timing information on the Data Base Controller and Display Controllers using the D-8028 Data Handler/Comparator. The PMA team was unable to collect the above data due to problems in using the nine-bit strobe discussed in paragraph III.1.c above, and a lack of available time.

c. Because the memory map data was collected late in the project, the PMA team was not able to make a conclusive analysis of the data. Further, ABACUS personnel did not have source listings for the RSX-11D operating system used on the System Controller. Copies of the memory maps were given to Project ABACUS personnel for their own analysis.

d. Scratch area contention measurement. The PMA team was unable to make a conclusive anlaysis of the data from this measurement because the data collected running the Fast Simulator did not represent a typical workload.

3. Findings.

a. Untapped system resources. The CTS contains much more power than is necessary for its present use in CMI. The one second terminal response time is no longer needed to assure that the student will maintain attention and move quickly through the instructional material. Data collected indicates that there is considerable untapped power in the system.

(1) I/O activity. The availability of untapped system resources is demonstrated by the low activity on the Direct Memory Access links (between the Data Base Controller (DBC) and the System Controller (SC) and Display Controller (DC)), and Programed I/O links (between the SC and the DC), as summarized in tables 4-1 and 4-2, below.

Table 4-1
Direct Memory Access Link Activity
(Expressed as a percent of measurement time)

	Between DBC/DC1	Between DBC/DC2	Between DBC/DC3	Between DBC/DC4	DMA Average
Fast Simulator	19.08%	20.59%	21.01%	22.65%	20.83%
Slow Simulator	2.33	2.06	1.97	2.58	2.23
Normal Daytime	.23	.56	.30	.37	.36

It is estimated that the Direct Memory Access links can support 40% activity. It follows that the amount of untapped I/O resources in the Direct Memory Access links is the difference between 40% and 2.23%, the Slow Simulator average, which is 37.77%. The Slow Simulator most nearly approximates the full four hundred student workload to be placed on the system. The Direct Memory Access links have 94.42% unused capacity (37.77 % ÷ 40% x 100 = 94.42%).

Table 4-2
Programed I/O Link Activity
(Expressed as a count of words transferred per minute)*

	Between SC/DC1	Between SC/DC2	Between SC/DC4	Average
Fast Simulator	3036.1	3051.7	2960.1	3015.9
Slow Simulator	593.5	598.4	607.7	599.8
Normal Daytime	72.0	130.1	54.4	85.5

*Programed I/O link activity between the System Controller and Display Controller 3 is not presented because the data collected was not complete.

The Fast Simulator average is close to the maximum average word per minute transfer rate for the Programed I/O links because the burst rate on these links probably approaches the 5100 word per minute maximum. The Slow Simulator average is 19.88% (599.8 ÷ 3015.9 x 100 = 19.88%) of the Fast Simulator average, indicating that the CTS Programed I/O links have 80.12% unused capacity (100% - 19.88% = 80.12%).

(2) CPU activity on the Data Base Controller. No instruction/data fetch activity map data was collected during the project. However, because I/O activity to and from the DBC was extremely low, it is apparent that CPU activity was very low also. This is because the only function of the DBC is to access the CTS data base. Further, data is sent or received through a Direct Memory Access link which requires very little CPU activity

to handle data transfers. Daytime Direct Memory Access activity to and from the DBC was less than one percent of total measurement time. It seems from this information that CPU idle time in the DBC is presently above ninety percent and would still be high when a full, four hundred student load is placed on the CTS.

b. Transfer of DIVA disk units to the System Controller.

(1) Unused DIVA disk drives. The Data Base Controller requires only one of the four available disk units to contain all present student material. Further, this one unit will still be sufficient to contain all student material when the full, four hundred student workload is placed on the system. Specifically, 200 of the 400 available cylinders on one DIVA disk pack have been filled with two-thirds of the intended course material on the system. To date, the full 31E (Radio Repair) course, half of the 31J (Teletype Repair) course, and half of the 35L (Avionics Repair) course have been put on the system. With only half the material for two courses remaining, the pack will be capable of holding all necessary course material.

(2) Improvement in instructor programer productivity.

(a) The instructor programers create the student lesson material on the System Controller in two steps. First the source code is entered and stored on the System Controller PK05 disk. The instructor programer assembles and then evaluates the student lesson material. If necessary, corrections are applied to the lesson material until the lesson material is the way the instructor programer wants it. When error free, the assembled student material is stored temporarily on disk and later dumped to tape. Then, the tape is loaded on the Data Base Controller's DIVA disk device 0.

(b) Project ABACUS personnel estimate that instructor programer productivity could be increased an estimated fifty percent if all three courses could be kept on line during development. Presently, only one course can be kept on line at one time, resulting in instructor programers being unable to work with their lesson material. However, the increased instructor programer productivity would be wasted unless:

1 More than the present three courses are to be installed on the system, or;

2 Extensive and continuous revisions of present course material are planned.

(3) The proposed transfer.

(a) Project ABACUS personnel want to eliminate this disk to tape processing and have more disk space for instructor programmer lesson data on the System Controller by replacing the three smaller DEC RK05 (1.2 million word capacity each) disk drives with the three unused DIVA (29 million word capacity each) disk drives from the DBC. This would necessitate the purchase of an additional DIVA disk controller, although it would allow three RK05 disk drives and their RK11D controller to be declared surplus.

(b) The data in table 4-3, below, shows that the transfer of the DIVA disk drives and purchase of the DIVA disk controller could be made at a $18,600 savings to the Army if, and only if, there is a demonstrated need for the transfer and another Army installation had guaranteed to reutilize the DEC RK11D disk controller and RK05 disk drives declared surplus.

Table 4-3
Savings possible in transferring DIVA disk drives

Value of DEC equipment made surplus:
RK11D controller		$ 9,900
3 RK05 disk drives		15,300
	Total	$25,200
Cost of DIVA DC-234 controller		6,600
Possible savings		$18,600

IV. Conclusions.

1. The Direct Memory Access links have 94.42% unused capacity, and the Programed I/O links have 80.12% unused capacity.

2. The DBC CPU has approximately 90% unused capacity.

3. The system, as designed and configured, is underutilized.

4. Only one of the four DIVA disk drives on the DBC is required to hold all of the lesson material for the three courses to be installed on the system.

5. Transfer of three of the DIVA disk drives from the DEC to the System Controller would improve instructor programmer productivity by an estimated fifty percent.

6. The increased instructor programmer productivity would be wasted unless additional courses are installed on the system or extensive revisions of present course material are planned.

7. Transfer of the three DIVA disk drives to the System Controller would require the purchase of a DIVA DC-234 disk controller.

8. The purchase of a DIVA disk controller and transfer of the three DIVA disk drives to the DEC would result in a DEC disk controller and three disk drives becoming surplus. If an Army installation required and could reutilize this equipment, then the total transaction would actually result in a savings to the Army of $18,600.
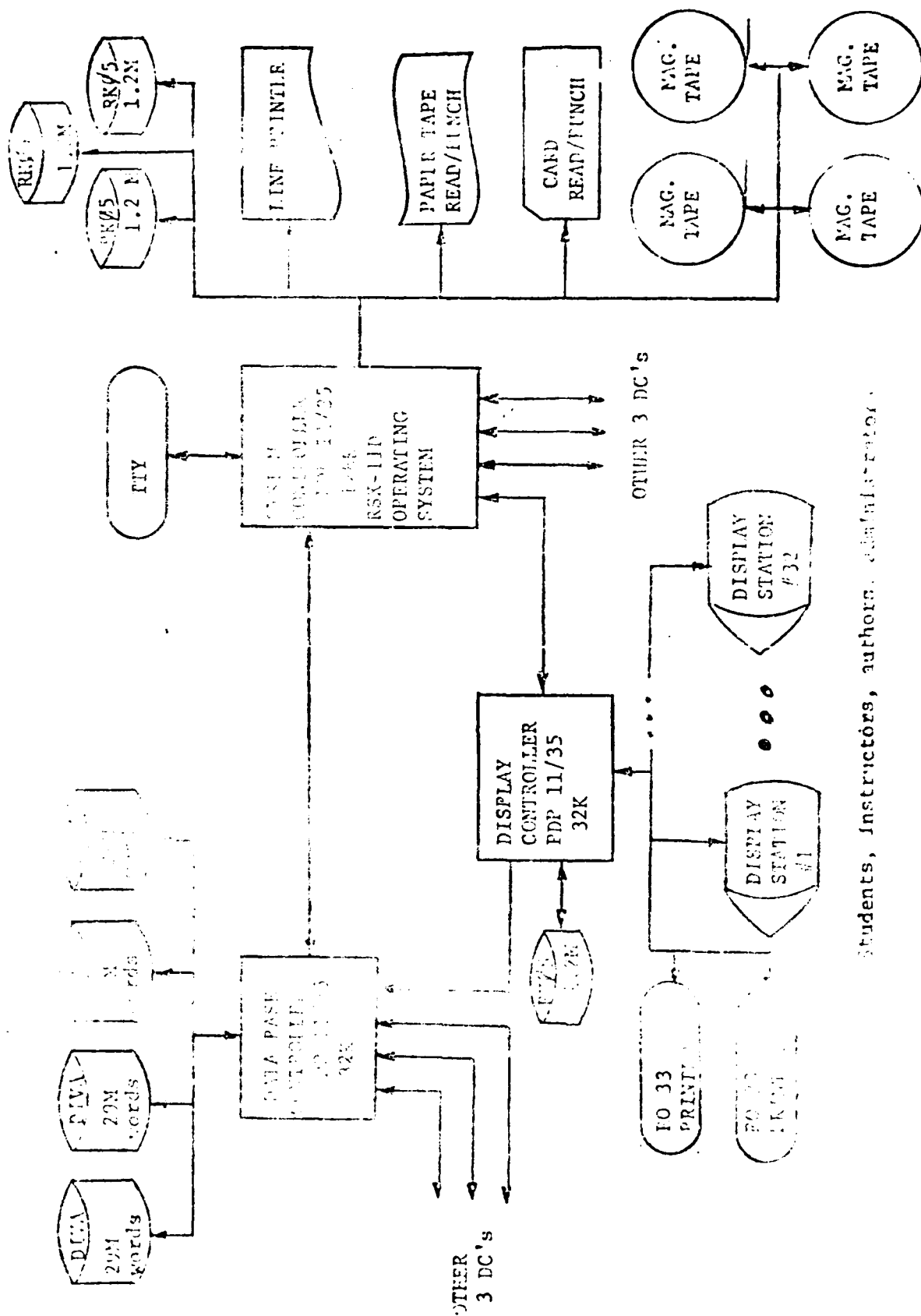
V. Recommendations.

1. That the system, as designed and configured, should not be proliferated.

2. That the purchase of the DIVA disk controller be approved only if there is a demonstrated need and an Army installation guaranteed to reutilize the surplused DEC equipment. Otherwise the three DIVA disk drives should be declared surplus.

APPENDIX A

pendix .. contains two charts of the hardware configuration of the
gital Equipment Corporation PDP 11/35 computer system used by Project
ACUS in the Computerized Training System (CTS). Figure 1 depicts the
S Functional Block Diagram. Figure 2 depicts the Inter-Computer Dat-

RK/5 1.2M

RK/5 1.2M

RK...

LINE PRINTER

PAPER TAPE READ/PUNCH

CARD READ/PUNCH

MAG. TAPE

MAG. TAPE

MAG. TAPE

MAG. TAPE

TTY

CENTRAL CONTROLLER PDP 11/35 64K RSX-11D OPERATING SYSTEM

OTHER 3 DC's

DISPLAY CONTROLLER PDP 11/35 32K

DISPLAY STATION #32

DISPLAY STATION #1

DATA BASE CONTROLLER PDP 11/35 32K

RK05

RP04 29M words

RP04 29M words

OTHER 3 DC's

TO 33 PRINT

TO 33 KEYB

Students, Instructors, authors, administrators
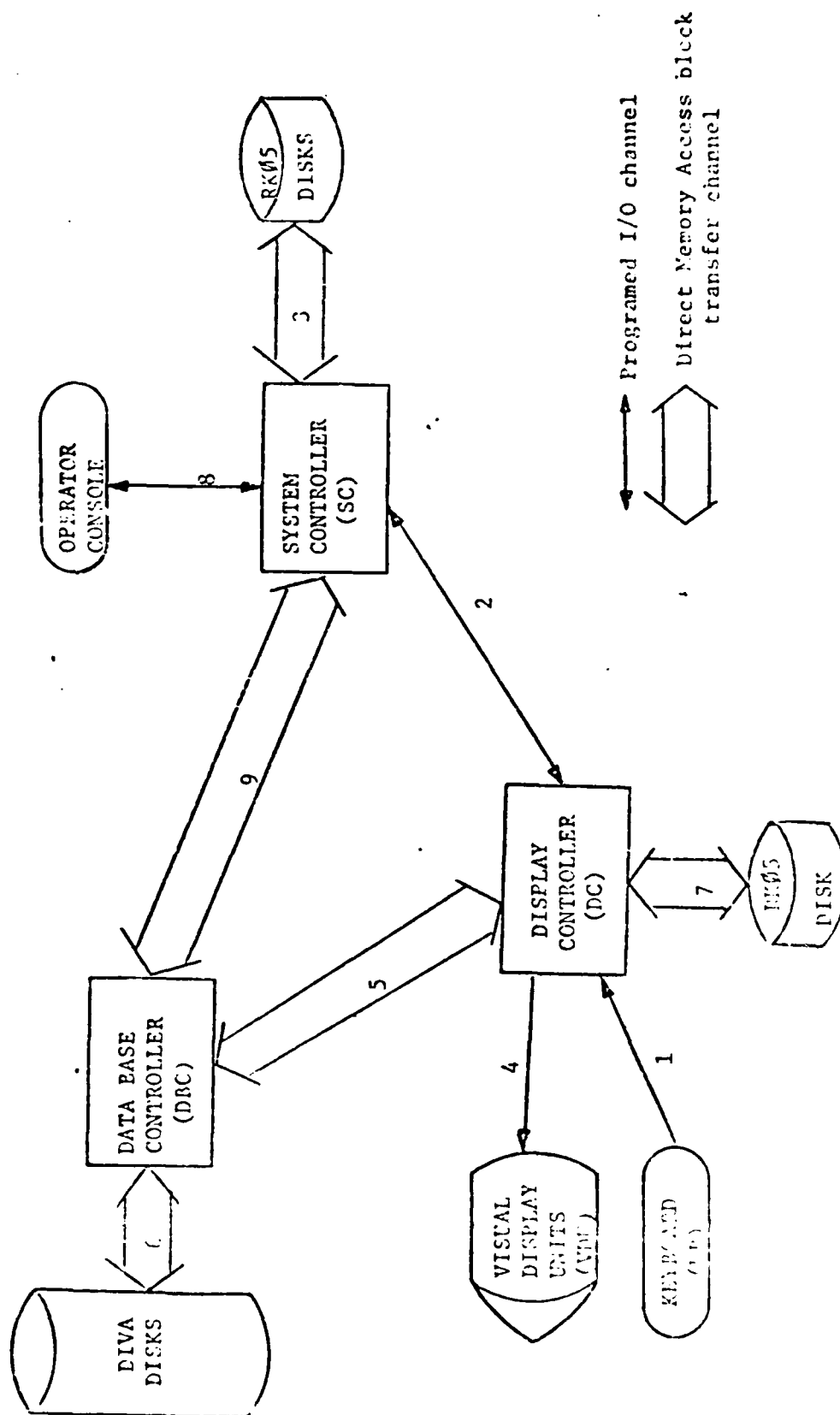
Figure 1. CIS Functional Block Diagram

Figure 2. Inter-computer Data Flow

APPENDIX B

Memorandum of Agreement

Appendix B contains a copy of the Memorandum of Agreement signed by representatives of Training Support Center Project ABACUS and US Army Computer Systems Support and Evaluation Agency.

MEMORANDUM OF AGREEMENT

BETWEEN

Product Manager	US Army Computer Systems Support
Computerized Training System	and Evaluation Agency
US Army Training Support Center	System Techniques and Analysis Directorate
Fort Eustis, VA	Washington DC

1. <u>Purpose.</u> The purpose of this Memorandum of Agreement ("MOA) is to:

   a. Define the specific measurement objectives of the Performance Measurement and Analysis (PMA) of the Project ABACUS Digital Equipment Corporation PDP-11/35 computer system located at Fort Gordon, GA.

   b. Identify the manpower and PMA tools which will be brought to bear upon the problem.

2. <u>Scope.</u> This MOA covers all activities relating to the PMA beginning 5 January through 25 March 1977. The specific schedule is for a two phase effort as follows:

   a. First preliminary (on-site) analysis: 5 through 8 January 1977.

   b. Second preliminary (on-site) analysis: 25 through 28 January 1977.

   c. Computer measurement and analysis: 22 February through 25 March 1977.

3. <u>General Objective.</u> The general purpose of the PMA is to collect data that will provide the Product Manager a sound basis for making recommendations to TRADOC and Department of Army concerning the prototype technical system, potential of individual components and those areas requiring further research and development.

4. <u>Specific Objectives.</u> The PMA will address the following specific objectives, each of which will be approached and completed in turn, time permitting. Each objective will be accomplished in the order that they are listed below. No succeeding objective will be initiated until the preceding objective has been satisfactorily completed. However, failure to complete an objective will not result in extending the measurement period.

   a. Objective 1. General I/O activity for the system to include the following:

      (1) All DA11B's (DMA Channels)

      (2) All DR11C's (Programmed I/O links)

      (3) DIVA Disk Activity

      (4) DEC RK05 Disk Activity at System Controller

b. Objective 2. Memory (instruction address) mapping of the system in the following priority:

   (1) System Controller.

   (2) Data Base Controller.

   (3) Display Controllers.

c. Objective 3. Determination of CPU idle time in the following priority:

   (1) System Controller.

   (2) Data Base Controller.

   (3) Display Controller.

5. Approach. The approach to analysis of data collection will be as follows:

a. Identify probable collection criteria.

b. Design measurement plan for collection of data necessary to validate identified criteria.

c. Make measurement(s).

d. Determine if measurement result prove cause(s) valid (if not, return to step 4a).

6. Resources to be Applied to the Project.

a. To be supplied by CSSEA:

(1) Manpower.

   (a) The assigned CSSEA PMA Project Leader is Mr. Gerald B. Dargusch, Computer Specialist, Performance Analysis Branch, CSSE-ST-P, telephone AUTOVON 227-4160/4175.

   (b) Level of support: Two performance analysts during the computer measurement and analysis phase of the project.

(2) PMA tools available:

   (a) Comten, Inc. D-8700 Hardware Monitor System.

   (b) Comten, Inc. DYNAPAR Hardware Monitor Data Reduction Software.

b. To be supplied by Project ABACUS:

(1) Manpower: Project ABACUS will assign, as project officer and PMA team member, an individual who is thoroughly familiar with the overall operation and software of the computer system. This project officer will

work as a member of the PMA team in developing and carrying out measurement plans and will be available fulltime for the life of the project. Additionally, Project ABACUS will make available other knowledgable personnel as necessary to answer technical questions or to respond to requests for workload information.

(2) Computer system time.

(a) Data reduction time will be provided at a nearby government installation.

(b) Stand-alone installation time up to one hour during several periods for probe point attachment and validation.

(3) Services of hardware vendor(s) customer engineers. Project ABACUS will make arrangements for payment of all charges incident to such services. Maximum effort will be made by the PMA team to accomplish these actions during normal PM time to preclude unnecessary costs. Where possible these services will be requested during normal preventive maintenance periods.

(4) Access to computer room. Project ABACUS personnel will assist the PMA team in determining the best location for the installation of the CSSEA D-8700 hardware monitor. Project ABACUS will arrange for PMA team member(s) access to the computer room. All Project ABACUS team members will have current secret or top secret clearances. Project ABACUS will assign escorts to those contractor personnel (customer engineer and software specialists on an as needed basis) who do not have the required clearances at times when it is necessary that such personnel have access to the Project ABACUS computer room to service CSSEA hardware monitors.

(5) Work space and support equipment: Arrangements will be made to:

(a) Make available desk or table space in proximity to Project ABACUS computer room for two performance analysts.

(b) Provide two tables (approximately 3' x 5' each) or carts with equivalent area, capable of supporting 350 pounds each, for installation of the CSSEA D-8700 hardware monitor.

(6) Project ABACUS will provide personnel to accept CSSEA hardware monitor and support equipment when it arrives and help with the installation of this equipment. Project ABACUS will also provide personnel to assist in packing and shipping the equipment at the completion of the test.
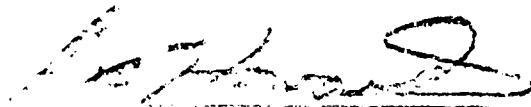
6. Installation of probes. Attachment of hardware monitor probes to the DEC system will be done only by DEC Customer Engineer personnel.

7. Constraints. Full realization of all objectives stated in this Memorandum of Agreement is contingent upon the success of CSSEA, Project ABACUS and DEC personnel in locating satisfactory points for hardware monitor probe attachment.

For the computer APARS
Application Teaching System

For U.S. Army Computer
Systems Support and Analysis
Agency.

_____

GERALD B. DARGUSCH
PMA Team Leader
Performance Analysis Division
Systems Techniques and Analysis Branch

24 January 77

27 January 1977
DATE

MEAN PROGRESSION INDICES
MANUAL SELF-PACED VS COMPUTERIZED SELF-PACED (CTS)
FIELD RADIO REPAIR COURSE, MOS 31E20

MEAN SCORES

ITEM		Self-Paced (N=59) SEP 76 – MAR 77	CTS (N=85) JAN 77 – MAR 77
Electronics Aptitude (EL)		116	110
General Technical (GT)		113	107
Task	**Hours**		
1	87	1.00	.92 (self-paced)
2	54	.48	.51 (self-paced)
3	36	.70	.80 (self-paced)
4	59	1.92	1.86
5	69	.50	.47
6	68	1.04	.54
7	56	1.14	2.11
8	50	.38	.54
9	33	.91	.29
10	25	1.08	1.49
11	23	.36	.47
12	24	.54	.32
13	24	.83	1.32
14	45	.29	.23
AVERAGE OF TASKS 4 THRU 14 =		.81	.87

PUBLICATION LIST

TITLE	CTD-TR #	DDC #
A Feasibility Study of Computer Assisted Instruction in US Army Basic Electronics Training. Feb 68	(None)	AD 745 402
The Implementation of Computer Assisted Instruction in US Army Basic Electronics Training. Sep 69	69-1	AD 704 339
Audio Utilization Conventions and Techniques for Computer Assisted Instruction. Mar 70	70-1	AD 704 338
An Automated Student Registration Procedure (REGIS). June 70	70-2	AD 710 983
A MACRO System for Computer Assisted Instruction. May 1970	70-3	(None)
Application of Computers to Training. Apr 71	71-1	AD 749 468
An Instructional Model for Computer Assisted Instruction. May 1971	71-2	AD 745 409
Instructional Programming Guide for Computer Assisted Instruction. Jul 71	71-3	AD 749 469
Task Group Report: CAI Volumes I & II. Apr 72	(None)	(None)
A Summative Evaluation of Computer Assisted Instruction in US Army Basic Electronics Training. May 1972	72-1	AD 749 470
Vacuum Tube/Solid State Circuit Survey Mar 73	73-1	AD 759 129
CLASS I Language: Document A (Specif. No: S-125-72). Apr 73	(None)	(None)

TITLE	CTD-TR #	DDC #
Record Formats: Booklet A (Specif. No: S-125-72). Apr 73	(None)	(None)
Concept Plan: Booklet B (Specif. No: S-125-72). Apr 73	(None)	(None)
Estimated System Use Factors: Document C. (Specif. No: S-125-72). Apr 73	(None)	(None)
A Preliminary Instructional Model for a Computerized Training System. Jul 73	73-2	AD 762 180
An On-Line Electronics Graphics Symbol Set for the PLATO IV System. Oct 73	73-3	AD 776 364
One Year Status Report Computerized Training System: Project ABACUS. Aug 73	73-4	AD 777 767
Preliminary Evaluation Plan for US Army Computerized Training System. Jan 74	74-1	AD 777 763
PLATO IV First Year Report Computerized Training System. Apr 74	74-2	(None)
Survey of Computer Applications in Army Training. Jun 74	74-3	AD 787 429
Second Year Status Report Computerized Training Systems Project ABACUS. Aug 74	74-4	AD A034443
Effective Writing for a Computerized Training System. Jan 75	75-1	AD A034444
Computer Applications in Army Training Present Status and Planned Activity. Apr 75	(None)	(None)
Instructional Effectiveness of the PLATO IV Plasma Terminal. May 1975	75-2	AD A034446
The Future of the Computer in Army Training. May 1975	75-3	AD A034438
Third Year Status Report Computerized Training Systems Project ABACUS. Aug 75	75-4	AD A034501

TITLE	CTD-TR #	DDC #
Project ABACUS Handbook on Program Documentation and Debugging. Feb 76	76-1	AD A034439
Course Development and Applications Programming Summary. Mar 76	(None)	(None)
Report on the Final Acceptance Test for CTS (Computerized Training System). Aug 76	76-2	(None)
The Testing of a Regression Model for Predicting Index in Various Army Courses. Oct 76	76-3	AD A034445
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